Amendments to the Specification:

On page 1, lines 9-10, please replace with the following:

The invention relates to ~~Ferroelectric~~ ferroelectric materials. More specifically, the invention relates to ~~Ferroelectric~~ ferroelectric materials with patterned domain structures.

On page 3, lines 9-21, please replace with the following:

The invention provides a method for domain patterning of nonlinear ~~Ferroelectric~~ ferroelectric materials. The method is particularly useful for domain patterning of ~~Ferroelectric~~ ferroelectric structures which exhibit low coercive fields and which exhibit charging with small changes in temperature. The method seeks to reduce the formation of random micro-domains that typically result during thermal cycling of ~~Ferroelectric~~ ferroelectric materials and which lead to patterning defects and reduced efficiencies. According to the preferred method of the invention, a ~~Ferroelectric~~ ferroelectric structure is provided with conductive layers on the top surface and the bottom surface of the structure which correspond to surfaces that are normal to the crystallographic polarization axis or z-polarization vectors. The conductive layer is a conductive polymer, a metal layer or a layer of conductive polymer composition. Preferably, the conductive layers are formed from a mixture of polyaniline salt, n–Methyl pyrrolidone and Isopropanol, available under the name of ORMECON™ D-1000 manufactured by Ormecon Chemie GmbH & Co. KG, Ferdinand-Harten-Str. 7, D-22949, Ammersbek, Germany.

On page 3, line 22 to page 4, line 3, please replace with the following:

A mask is provided over a patterning surface of the structure. For simplicity, the patterning surface is referred to herein as the top surface of the structure. The mask preferably substantially replicates the intended domain pattern. Portions of the conductive layer on the top surface of the structure are removed in accordance with the pattern of the mask, thus leaving a conductive domain template on the top surface of the structure. Subsequently, a sufficient bias voltage is applied to the conductive domain template and the conductive layer on the bottom surface of the structure, thereby producing a domain patterned ~~Ferroelectric~~ ferroelectric structure. The conductive layer, the mask and the conductive domain template are then preferably removed from the structure. The resulting domain patterned ~~Ferroelectric~~ ferroelectric structure is then relatively stable against charging effects due to temperature variations. A final

protective conductive coating may be applied to provide additional long-term stability of the domain pattern.

On page 4, lines 4-9, please replace with the following:

The mask is preferably provided by lithographic techniques by using lithographic materials. Accordingly, a portion of the conductive layer on the top surface of the ~~Ferroelectric~~ ferroelectric structure is coated with a photo-resist such by any suitable method. After the photo-resist is coated on the top conductive layer, the photo-resist is thermal cycled in accordance with the manufacturer's recommendations. The photo-resist is then exposed according to a predetermined pattern with a suitable light source and developed to form the mask.

On page 4, lines 10-16, please replace with the following:

During thermal cycling of the photo-resist, charging on the surfaces of the ~~Ferroelectric~~ ferroelectric typically occurs leading to electron emission and random domain formation during cooling. In order to mitigate the charging of the structure during thermal cycling of photo-resist, it is preferable that the conductive layers on the top surface and the bottom surface are placed in electrical communication prior to thermal cycling, thus reducing the charging. The top and bottom conductive layers are preferably placed in electrical communication by providing a conductive layer to a side surface of the ~~Ferroelectric~~ ferroelectric structure.

On page 4, lines 17-25, please replace with the following:

After the mask is formed and prior to creating the domain patterning, the conductive layer on the top and bottom surfaces of the structure is placed in electrical isolation by removing the conductive layer from the side surface of the structure and applying a sufficient bias voltage across the top and bottom conductive layers. This urges the ~~Ferroelectric~~ ferroelectric structure to assume a single domain structure, wherein the signs of the polarization vectors are in one direction throughout the structure. The voltage that is required to uniformly polarize the structure depends on the ~~Ferroelectric~~ ferroelectric material used, but is approximately 21 KV/mm or less for many ~~Ferroelectric~~ ferroelectric materials and is defined by the coercive field Ec of the material used to form the structure and the thickness of the structure.

On page 4, line 26 to page 5, line 3, please replace with the following:

After the mask is formed and the structure is uniformly polarized, portions of the conductive layer on the top surface are removed in accordance with the mask to form a conductive domain template. A sufficient reverse bias voltage is then applied across the conductive domain template and the conductive layer on the bottom surface of the ~~Ferroelectric~~ ferroelectric structure causing the regions of the structure between the domain template and the conductive layer on the bottom surface to reverse their polarization, thereby creating the domain patterning throughout the ~~Ferroelectric~~ ferroelectric structure.

On page 5, lines 4-10, please replace with the following:

The ~~Ferroelectric~~ ferroelectric structure is preferably formed from $LiNbO_3$, $KTiOPO_4$ and $LiTaO_3$. Most preferably, the ~~Ferroelectric~~ ferroelectric structure is a stoichiometric $LiNbO_3$ or $LiTaO_3$ wafer which exhibits a low coercive field. Further, the domain patterned ~~Ferroelectric~~ ferroelectric structure is preferably a quasi-phase matching structure wherein the domains are spatially modulated by a distance corresponding to a coherence length required for generating a harmonic emission wave form with a wavelength λ_e from a fundamental wave form of an interacting light source with a wavelength λ_i.

On page 5, lines 11-18, please replace with the following:

A harmonic generator for generating a harmonic emission wave form utilizes the quasi-phase matching structure of the instant invention formed from a ~~Ferroelectric~~ ferroelectric material which exhibits spontaneous reversal of local polarizations by changes in temperature ΔT between 0.1 and 40 degrees, wherein $\Delta T, = q^{-1} \cdot \xi \cdot E_c$, q is the pyroelectric coefficient, ξ is the permitivity of the ~~Ferroelectric~~ ferroelectric and E_c is the coercive field. An interacting light source, with the fundamental wavelength λ_i is configured to be incident with the quasi-phase matching structure such that a portion of the light with the wavelength λ_i interacts with the quasi-phase matching structure generating the harmonic emission wave form with a wavelength λ_e.

On page 5, lines 21-28, please replace with the following:

Figure 1 is a schematic representation of a harmonic generator.

Figure 2 is a schematic representation of a periodically poled nonlinear structure.

Figure 3 is a block flow diagram outlining the method for making a periodic domain patterned ~~Ferroelectric~~ ferroelectric structure in accordance with the invention.
Figure 4a-g illustrates the steps of making a periodic domain patterned ~~Ferroelectric~~ ferroelectric structure according to the preferred embodiment of the invention.
Figure 5 shows a structure with domain patterning on a high coercive field ~~Ferroelectric~~ ferroelectric
Figure 6 shows a structure with domain patterning on a low coercive field ~~Ferroelectric~~ ferroelectric.

On page 6, lines 2-22, please replace with the following:

In general, the present invention is for domain patterning of ~~Ferroelectric~~ ferroelectric materials used in nonlinear optics and related applications. ~~Ferroelectric~~ ferroelectric materials such as $LiNbO_3$, $KTiOPO_4$ and $LiTaO_3$ have been implicated as suitable candidates in QPM structures. When exposed to sufficient changes in temperature, ~~Ferroelectric~~ ferroelectric materials produce a surface charge. The surface charge gives rise to an electric field having a component that is parallel to the polar axis of the ~~Ferroelectric~~ ferroelectric material. This phenomenon is called the pyroelectric effect. Some ~~Ferroelectric~~ ferroelectric materials such as $LiNbO_3$ and $LiTaO_3$, produce a surface charge that produces such an anti-polar electric field during cooling, while other materials produce an anti-polar electric field during heating, both of which can lead to spontaneous reversal in the sign of the local polarization vector. This spontaneous reversal in the sign of the local polarization vector produces random micro domains in the structure. The process of reversing the sign of the local polarization vector is referred to as poling. The change in temperature that is required to cause the spontaneous reversal of the local polarization is given by $\Delta T = q^{-1} \cdot \xi \cdot E_c$, where q is the pyroelectric coefficient, ξ is the permitivity of the ~~Ferroelectric~~ ferroelectric and E_c is the coercive field. In congruent lithium tanatlate, for example, an anti-polar field sufficient to cause the sign of polarization vectors to spontaneously switch is generated at a ΔT of approximately 50 degrees Kelvin, wherein the coercive field value of the material is 21 kV/mm. In commercially available stoichiometric lithium tanatlate, such as available by Oxide Corporation, 9633 Kobuchizawa, Kitakoma, Yamanashi, 408-0044 Japan, the coercive field is much lower, approximately 1.7 kV/mm. This lower coercive field reduces the temperature decrease that results in poling to approximately 4.0 degrees.

On page 6, line 23 to page 7, line 4, please replace with the following:

To achieve periodic domain inversion or domain patterning on the surfaces of ~~Ferroelectric~~ ferroelectric materials, dopant infusion has been employed; for example, see E. J. Lim, M. M. Fejer, and R. L. Byer, "Second-Harmonic Generation of Green Light in Periodically Poled Planar Lithium Niobate Waveguides," Electronics Letters, 25 (3), pp. 174-175, 1989. In order to achieve bulk periodic domain formation, lithographic techniques have been employed, whereby the domains are defined by lithographic techniques and a sufficient electric field is applied to the ~~Ferroelectric~~ ferroelectric material to cause inversion of the nonlinear coefficient. For early work describing using lithographic techniques for domain patterning, see M. Yamamada, N. Nada, M.. Saitoh et al., "First Order Quasi-Phase Matched $LiNbO_3$ waveguide Periodically Poled by Applying an External Field for Efficient Blue Second-Harmonic Generation," Applied Physics Letters, 62 (5), pp. 435-436, 1993.

On page 7, lines 5-12, please replace with the following:

Unfortunately Lithographic processes and other wafer processing steps typically involve thermal cycling ΔT that can be on the order of 100 degrees or more and can readily result in the formation of random micro-domains. The formation of random micro domains in the ~~Ferroelectric~~ ferroelectric material results in defects in subsequently produced domain patterned structures and degrades the performance of the QPM device produced therefrom. Therefore, there is a need for an improved method for making periodic domain patterned structures from ~~Ferroelectric~~ ferroelectric materials, wherein high resolution domain patterning is achieved using lithographic techniques, but where the formation of random micro domains is reduced during thermal cycling processes.

On page 7, lines 18-21, please replace with the following:

There are several potential advantages to using these low coercive field ~~Ferroelectric~~ ferroelectric materials. In some ~~Ferroelectric~~ ferroelectric materials, a lowered coercive field can result in substantial improvement in domain patterning. Further, some domain patterned low coercive field materials show good optical stability.

On page 7, line 22 to page 8, line 1, please replace with the following:

Figure 2 is a schematic representation of a periodically poled nonlinear structure 203. The structure has alternating domains 203 and 205, wherein the sign of the respective polarization vectors 204 and 206 alternate. The preferred separation of alternating domains are discussed by J. A. Armstrong, N. Bloembergen, J. Ducuing and P.S. Pershan in "Interaction Between Light Waves in a Nonlinear Dielectric," Phys. Rev., 127, 1918, 1962. The polarization in a domain of the structure 201 can be poled or switched by applying the sufficient bias voltage across the top surface and the bottom surface of the structure 201 which is normal to the polarization vectors 204 and 206, viz. the coercive field times the distance 209. Coercive field value for ~~Ferroelectric~~ ferroelectric materials are in the range of about 10V/mm to 20 KV/mm

On page 8, lines 2-13, please replace with the following:

Figure 3 is block diagram outlining the method for making a periodic domain ~~Ferroelectric~~ ferroelectric structure in accordance with the instant invention. In the step 301 a ~~Ferroelectric~~ ferroelectric material is provided. The ~~Ferroelectric~~ ferroelectric material is either a high or a low coercive Field ~~Ferroelectric~~ ferroelectric, but is preferably a material that is substantially formed from $LiNbO_3$, $KTiOPO_4$ or $LiTaO_3$ and exhibits a coercive field value such that the material exhibits a spontaneous reversal of the local polarization with a change in temperature in the range of 0.1 to 40 degrees. In the step 303, conductive layers are provided on opposite surfaces that are substantially normal to the polarization vector axis. The conductive layers are formed from a conductive polymer, a metal or a salt composition material. According to the preferred embodiment of the invention, the conductive layers are formed from a mixture of polyaniline salt, n–Methyl pyrrolidone and Isopropanol, available under the name of ORMECON™ D-1000 manufactured by Ormecon Chemie GmbH & Co. KG, Ferdinand-Harten-Str. 7, D-22949, Ammersbek, Germany.

On page 8, lines 14-20, please replace with the following:

In a further embodiment of the instant invention the conductive layer includes a conductive polymer or a salt composition material in contact with the low coercive field ~~Ferroelectric~~ ferroelectric material and a metal deposited on top of the conductive polymer or a salt composition material. In accordance with this embodiment, it is preferable that the metal is not in direct contact with the low coercive field ~~Ferroelectric~~ ferroelectric material because some

metals may react with the low coercive field ~~Ferroelectric~~ ferroelectric material and modify the electrical and/or optical properties of the material.

On page 8, line 21 to page 9, line 3, please replace with the following:

After the conductive layers are provided in the step 303, then in the step 305 a mask is formed on one of the conductive layers. The mask is preferably provided using lithographic techniques and using lithographic materials. A portion of the conductive layer on the top surface of the ~~Ferroelectric~~ ferroelectric structure is coated with a photo-resist. After the photo-resist is coated on the top conductive layer, the photo-resist and the structure is thermal cycled in accordance with the manufacturer's recommendations. The photo-resist is then exposed with a suitable light source according to a predetermined pattern and developed to form the mask. After the mask is provided in the step 305, then in the step 307 a single domain structure is formed. The single domain structure is formed by applying a sufficient bias voltage to each of the top and the bottom conductive layers to pole the polarization vectors in one direction. The voltage applied across the conductive layer on the top surface and the conductive layer on the bottom surface is equal to or greater than the coercive field times the thickness of the structure.

On page 8, lines 4-12, please replace with the following:

Once the single domain structure is created in the step 307, then a conductive material is applied to the structure in the step 308 and the structures may be stored in the step for processing at a later time. In accordance with the embodiment, prior to the step 311 of removing a portion of one of the conductive layers, in the step 312 the conductive material on the sides of the structures shorting the top and bottom conductive layer is removed to place the top and the bottom conductive layers in electrical isolation. Either after the step 307 or the step 312, in the step 309, portions of the conductive layer are removed such that the conductive layer substantially replicates the mask and leaves a conductive domain template on the top surface of the ~~Ferroelectric~~ ferroelectric structure.

On page 9, lines 23-28, please replace with the following:

Figure 4a-g illustrates the steps for making a periodic ~~Ferroelectric~~ ferroelectric domain structure according to the preferred embodiment of the invention. Referring to Figure 4a, the ~~Ferroelectric~~ ferroelectric structure 401 is coated with conductive layers 420 and 421 on the top

surface 405 and bottom surface 403. The structure 401 is preferably a low coercive field $LiNbO_3$ and $LiTaO_3$, as described above and the top surface 405 and the bottom surface 403 and 404 correspond to surfaces which are normal to the vectors of polarization 406 and 407.

On page 11, lines 10-17, please replace with the following:

After the structure 401" is formed, then the conductive coating 421, the mask 433 and the conductive domain template 420' are removed and the domain patterned ~~Ferroelectric~~ ferroelectric structure 401" is ready to be coupled with a light source in the harmonic generator apparatus. Alternatively, the structure 401" is coated with protective layers 440 as shown in Figure 4g. Having described the preferred method of patterning a ~~Ferroelectric~~ ferroelectric material, Figures 5-6 are used to illustrated the additional advantage of using low-coercive field ~~Ferroelectric~~ ferroelectric materials in combination with the patterning method described above to make quasi-phase matching structures.

On page 11, line 18 to page 12, line 3, please replace with the following:

Figure 5 shows schematic view 500 of a patterning fixture for patterning high coercive field ~~Ferroelectric~~ ferroelectric material 501. Arcing can occur between a conductive layer on the top surface 502 and a conductive layer on the bottom surface 508, when electric fields as low as 3 kV/mm are applied. Thus the patterned conductive portions 503, 505, 507, 509 and 511 on the top surface 502 of the material 501 are often required to be significant distances D_1 and D_2 from the edges 504 of the material 501 to prevent arcing between conductive the portions 503, 505, 507, 509 and 511 on the top surface 502 and the conductive layer (not shown) on the bottom surface 508, when a poling voltage is applied from the voltage source 520. A second disadvantage to using high coercive field ~~Ferroelectric~~ ferroelectric materials to make quasi-phase matching structures is that the conductive patterned portions 503, 505, 507, 509 and 511 often need to be placed in electrical conductivity through connections 515 provided in a separated processing step, such as applying a liquid electrolyte between the conductive patterned portions 503, 505, 507, 509 and 511. Further, because the top surface 502 of the material 501 is under utilized, for the reasons described above, suitable contact points 517 for the voltage source 520 is limited and a special fixture and procedure can be required for each different patterned structure produced.

On page 12, lines 4-14, please replace with the following:

In contrast to Figure 5 and the procedures outlined above, Figure 6 shows a schematic view of a patterning fixture 600 for patterning a low coercive field ~~Ferroelectric~~ ferroelectric material 601. In the above example, arcing around the edge of the wafer is due to the low dielectric strength of air, which is approximately 3kV/mm. As explained above, high coercive field ~~Ferroelectric~~ ferroelectrics require special fixtures and require that D_1 and D_2 are large. Low coercive field ~~Ferroelectric~~ ferroelectrics require fields that are less than 3kV/mm to pole the domains and, therefore, can permit for the use of conductive layers 602 and 608 which go to, or near to, edges 604 and 604' of the wafer 601, while still reducing the chance of arcing when a poling voltage is applied. Also, because a greater area of the top surface 602 is utilized, the contact point 617 for the voltage source 620 can be almost anywhere that there is conductive material and a special fixture and procedure is not required for each different pattern structure produced.

On page 12, lines 15-22, please replace with the following:

The present invention has been described relative to a preferred embodiment. Improvements or modifications that become apparent to persons of ordinary skill in the art only after reading this disclosure are deemed within the spirit and scope of the application. Specifically, the present invention is for providing domain patterning of any type of ~~Ferroelectric~~ ferroelectric materials including high coercive field ~~Ferroelectric~~ ferroelectric materials and composite ~~Ferroelectric~~ ferroelectric materials. The periodic domain patterned structures of the instant invention are useful in any number of optical, and electrical and acoustic devices including, but not limited to, waveguides and harmonic generator devices.